KLIMDUKH, Aleksandr Mikhaylovich; IVANOV, V., red.; ZELENKOVA, Ye.,
[redacted]

[Calculating the assembly-line building of standard apartment houses] Raschet potochnogo stroitel'stva seriinykh zhilykh domov. Kiev, Gos.izd-vo lit-ry po stroit. i arkhit. USSR, 1959. 206 p. (MIRA 12:9)
(Apartment houses) (Assembly-line methods)

KLINDUKH, A.M.

KLINDUKH, A.M., kand.tekhn.nauk

Drawing up estimates for unfinished building in constructing apartment houses using assembly-line methods. Trudy NIIMI no.14:283-294 '59. (MIRA 13:1)

1. Nauchno-issledovatel'skiy institut organizatsii, mekhanizatsii i ekonomiki stroitel'stva Akademii stroitel'stva i arkhitektury USSR.

(Building--Estimates) (Assembly-line methods)

SLIPCHENKO, P.S., glav. red.; KUCHERENKO, K.R., red.; FILONENKO, K.I., red.; LESNAYA, A.A., red.; ABYZOV, A.G., red.; BUDNIKOV, M.S., red.; VETROV, Yu.A., red.; GLADKIY, V.I., red.; GOLOSOV, V.A., red.; IZMAYLOV, V.G., red.; KANYUKA, N.S., red.; KAIPOV, E.A., red.; KLINDUKH, A.M., red.; KUSHNAREV, N.Ye., red.; LUYK, A.I., kand. tekhn. nauk, red.; NEMENKO, L.A., red.; RYBAL'SKIY, V.I., red.; SITNIK, I.P., red.; FEDOSENKO, N.M., red.; FILAKHTOV, A.L., kand. tekhn. nauk, red.; KHILOBOCHENKO, K.S., red.; VORONKOVA, L.V., red.; KIYANICHENKO, N.S., red.

[Construction industry: technology and mechanization of the construction industry; the economics and organization of construction] Stroitel'noe proizvodstvo: tekhnologiia i mekhanizatsiia stroitel'nogo proizvodstva; ekonomika i organizatsiia stroitel'stva. Kiev, Budivel'nyk, 1965. 180 p. (MIRA 18:4)

1. Nauchno-issledovatel'skiy institut stroitel'nogo proizvodstva. 2. Nauchno-issledovatel'skiy institut stroitel'nogo proizvodstva (for Luyk, Filakhtov).

KAPLAN, Isaak Isaakovich; BOYKO, A.A., retsenzent; KLIMDUKHOV, A.A., retsenzent; NOSIK, Ye.I., retsenzent; KRASNIKOVSKII, O.V., otv. red.; GOLUBYATNIKOVA, G.S., red. izd-va; MINSKER, L.I., tekhn. red.

[Use of new equipment and techniques in coal mining; basic stages of technological progress in the Donets Basin mines] Vnedrenie novoi tekhniki v ugol'noi promyshlennosti; osnovnye etapy tekhnicheskogo progressa na shakhtakh Donbassa. Moskva, Gos. nauchno-tekhn.izd-vo lit-ry po gornomu delu, 1961. 93 p. (MIRA 15:2)
(Donets Basin—Coal mines and mining)

VASIL'YEV, V.P.; VASIL'YEVA, V.N.; KLINDUKHOVA, N.A.; PARFENOVA, A.N.

Equilibria in aqueous solutions of calcium, strontium, and barium nitrates. Izv.vys.ucheb.zav.;khim. i khim.tekh. 6 no.2:339-341 '63. (MIRA 16:9)

1. Ivanovskiy khimiko-tekhnologicheskiy institut, kafedra analiticheskoy i fizicheskoy khimii.
(Alkaline earth nitrates) (Complex compounds)

FILIPIC, Ivan, dipl. inz. (Ljubljana); KLINE, Alojz, dipl. inz. (Ljubljana)

Corona stabilizer tube. Elektr vest 31 no.3/5:77-79 Mr-My '64.

1. Iskra Electronic Equipment Plant, Incandescent Lamp Branch, Ljubljana, Kotnikova 16.

KLINE, Gordon M.

Research work on polymers at the National Bureau of Standards.
Polimery twors wielk 7 no.12:444-452 D '62.

1. Polymers Division, National Bureau of Standards, Washington, D.C.

KLINEC, A.

GEOGRAPHY & GEOLOGY

Periodicals: GEOLOGICKE PRACE; ZEPRAVY No. 12, 1958

KLINEC, A. Geologic notes on the crystalline rocks in the Ziar Mountain Range. p. 86.

Monthly List of East European Accessions (EEAI) LC, Vol. 8, No. 5, May 1959, Unclass.

KLINEC, A.

GEOGRAPHY & GEOLOGY

Periodicals: GEOLOGICKE PRACE; ZPRAVY. No. 12, 1958

KLINEC, A. Crystalline rocks in the northeastern part of the Lower Magura Mountains. p.93.

Monthly List of East European Accessions (EEAI) LC, Vol. 8, No. 5, May 1959, Unclass.

KLINER, R.

POLAND

KLINER, Rudolf, First Clinic of Obstetrics and Gynecology (I Klinika Poloznictwa i Chorob Kobiecych), AM (Akademia Medyczna, Medical Academy) in Krakow (Director of clinic: Prof. Dr. Stefan [illegible])

"Oxytocinase -- Biochemistry and Clinical Use."

Warsaw, Polski Tygodnik Lekarski, Vol 17, No 51, 17 Dec 62, pp 2001-20[illegible].

Abstract: Author reviews the progress made in biological determination of oxytocinase as a result of progress in hormone synthesis, reviews from the literature our present state of knowledge of this enzyme and its clinical uses in obstetrics. He calls for further studies of its role in the human organism and acquaintance of physicians with its effects. The 37 references, include 7 Polish, 1 Czech, [illegible] German, and the balance English references.

1/1

8/194/62/000/006/009/232
D222/D309

AUTHOR: Kliner, Josef

TITLE: The Aritma 520 calculating machine

PERIODICAL: Referativnyy zhurnal. Avtomatika i radioelektronika, no. 6, 1962, abstract 6-1-84 v (Inform. služba pracovniky SPS Aritma, no. 24-25, 478-482)

TEXT: The Aritma 520 is a decimal, relay, digital computer, using the code 8, 4, 2, 1. The machine has 15 decimal digits and ensures the automatic carry-over for numbers exceeding 9 into the next digit. Addition is done pairwise, i.e. to the first term is added the second, to their sum - the third, and so on. Subtraction is done by adding to the minuend the ten's complement of the subtrahend. Multiplication is done by multiplying automatically the multiplicand by each digit of the multiplier with a subsequent addition of the results, and making use of the principle of short-cut multiplication by representing the digits of the multiplier N, exceeding 4, in the form 10-N. Division is done by multiplying the divider by 3, 3, 2 and 1 with a subsequent subtraction or addition
Card 1/2

The Aritma 520 calculating machine S/194/62/000/006/009/232
D222/D309

with the remainder. Examples of the arithmetical operations are given. 1 figure. [Abstractor's note: Complete translation.]

Card 2/2

38726

S/194/62/000/005/003/157
D222/D309

9,7100

AUTHORS: Hylebrant, Karel and Kliner, Josef

TITLE: New programming plates for the Aritma 520

PERIODICAL: Referativnyy zhurnal. Avtomatika i radioelektronika, no. 5, 1962, abstract 5-1-57k (Inform. služba pracovniky SPS Aritma, 1961, no. 26, 498-508)

TEXT: New plates are described for the programming of the division (± A ± B): ± C at a speed of 4000 operations/hour (plate no. 38), for the checking of this operation obtained by a multiplication executed at the same speed (plate no. 39), for the multiplication ± A.(± B ± C) at a speed of 8000 operations/hour (plate no. 40), and for checking of this operation at the same speed (plate no. 41). All operations can be executed on 9-digit decimal numbers. Time-diagrams of the operation of the calculator are given, together with a drawing of the plates, and an example of a composite division is followed through, indicating the sequential operation of individual elements and units. 8 figures. [Abstractor's note: Complete translation].

Card 1/1

KL.NER, Karel, inz.

Dependence of the evaporation from bare earth surface on meteorological factors and soil moisture. Vodni hosp 14 no.8:283-288 '64.

1. Research Institute of Water Resources Management, Prague.

Kling, R.

5

A rapid method for determining the total amount of arsenic in commercial calcium arsenate by means of ion exchanger. Renata Kling and Janusz Lindeman (Polytech. Inst. Tech. nol., Wroclaw, Poland). Chem. Tech. (Warsaw) 2, 131 (1957) (English and Russian summaries). Arsenic was oxidized with HNO_3 and $KBrO_3$ to As^{5+}, then the soln. was acidified with HCl and passed through a column with a suitable prepd. cationite. As^{5+} was detd. iodometrically in the eluate. A phenol-methylene sulfone Polish cationite K_1 was used. In case of standard solns., results obtained by the ion-exchanger method are too low (about 3%). Comparative measurements by distn. according to the Polish Standards PN/C-2/010 and those by ion-exchanger method gave good agreement. The analysis takes half as long as distn. and a simpler app. is required. I. Kuraś.

Distr: 4E2c

Volumetric method for determination of sulfates in the presence of chromium. Renata Kllar (Zakład Anal. Inst. Chem. Nieorg., [illegible], Poland). Chem. Anal. [illegible] 817-20 ([illegible]).—To a sample contg. 0.03-0.4 g. SO_4^{--} and about 1.26 g. CrO_3, add HCl or NaOH to pH 4.8-5.5. Then add 20 ml. acetone, 10 ml. 20% NH_4Cl, and 5 ml. 10% AcOH. Titrate with 0.1*N* $BaCl_2$ until a paper strip satd. with Na rhodizonate as indicator turns pink. The method was proven for standard solns. contg. SO_4^{--} and CrO_3. The mean error varied from −3 to +3.5%. The method was applied to the analysis of waste products of chromic acid manuf., which contained about 4% CrO_3 and about 18% SO_4^{--} and for analysis of tanning liquor contg. about 12% CrO_3 and about 30% SO_4^{--}. The results were compared with those obtained by the gravimetric method.

Z. Kurtyka

4

KLING, E.,

VERNER, A., SUKHORUKOV, K. T., GERBERICHIAU, E., and BARABANOVA, G. "Bioclimatic Causes, Which Condition the Resistance of Plants to Parasitic Infections," Biulleten' VII Vsesoiuznogo S'ezda po Zashchite Rastenii v Leningrade 15-23 Noiabria 1932 Goda, no. 7, 1932, pp. 24-25, 423.92 V96

So: Sira S1-90-53, 15 Dec. 1953

PROCESSES AND PROPERTIES INDEX

11 A

Formation and distribution of bios. K. Sukhorukov, E. Kling and D. Klvachko. Compt. rend. acad. sci. U.R.S.S. 1, 504-9 (in English 311)(1935). Investigations upon bios were carried out, the bios catalyst being identified by the "yeast method." Increased nutrition with sol. carbohydrate does not increase bios formation, nitrate N markedly lowers the bios content, ammonia N raises it, and the addn. of glucose to the sources of N does not affect bios formation. Stimulants of the bios type are widely distributed in living organisms, the formation of bios proceeding in the green cell under the action of the highly refrangible part of the solar spectrum.

Edward Eagle

A.S.M.-S.L.A. METALLURGICAL LITERATURE CLASSIFICATION

A M

SUKHORUKOFF (K.), KLINGE (K.), & OVČAROV [OVTCHAROFF] (K.). The effects of Phytophthora infestans de Bary on the ferments of affected plants.—*C.R. Acad. Sci. U.R.S.S.*, N.S., xviii, 8, pp. 597-602, 1938.

Referring to Lepik's work [*R.A.M.*, viii, p. 596], the results of which appear to indicate that *Phytophthora infestans* is able to use the starch in potato tubers infected by it, the authors state that in their own aseptically conducted experiments the fungus consistently failed to grow in media containing starch as the source of carbon in the absence of extraneous diastase, and that its mycelium was shown by biochemical tests not to contain amylase. They further refer to investigations in 1923 by Hasse and Schweigart, who found that the activity of amylase in potato tubers is very low, a fact which was confirmed by them. The authors claim to have established by special tests [some details of which are given] that potato foliage and tubers contain a substance inhibiting amylolytic reactions, which they tentatively identify with sistoamylase, described in 1933 by Chrzaszcz and Janicki [Janitzki] as existing in the seeds and shoots of buckwheat and cereals. Further determinations showed that the amount of sistoamylase is considerably greater in varieties (*Solanum demissum* and 8670 JKH) immune from or highly resistant to *P. infestans* than in Early Rose,

which is very susceptible; the quantity is not constant, however, in
potato tubers, but undergoes noticeable changes during the resting
period. In yet another series of experiments it was found that in
developing on potato (Lorch) tubers the fungus gradually reduced their
content of sistoamylase, a peculiarity which is believed to play a promi-
nent part in its biology and in its pathogenicity to the potato. By
lowering the content of the potato plant in sistoamylase, which is
stated to hinder the development of other micro-organisms, it renders
the potato tubers accessible to secondary putrefactive organisms.

R. of AM.

SUKHORUKOV (K.) & KLIMM (K.). Influence of copper upon the Potato plant.—*C. R. Acad. Sci. U.R.S.S.*, N.S., xlvii, 6, pp. 436–438, 1945.

Leaves from potato plants treated with copper and inoculated with a highly virulent suspension of the conidia of *Phytophthora infestans* showed after four days a poor growth of mycelium of the fungus, with slight formation of conidia and sharply delimited, dark necroses to the extent of 30 per cent. of the leaf, whereas the controls showed 100 per cent. darkening of the whole leaf, with good growth of mycelium and normal conidial formation. Further experiments showed that, while the growth of *P. infestans* was stimulated in culture by the presence of 0·125 per cent. copper and depressed by stronger solutions, peroxidase activity [*R.A.M.*, xix, p. 300] was greater in the copper-treated leaves than in the controls (in the proportion of 18·1 to 12·2). Potato species and varieties immune from *P. infestans* showed a higher peroxidase activity than susceptibles, and the authors believe that copper does not only protect the plant directly by its toxic action but indirectly through a change induced in the physiological properties of the plant.

Tomsk State U.

PA 36/49T40

KLING, E.

USSR/Medicine - Botany
Medicine - Biography

Jan/Feb 48

"In Memory of Andrey Aleksandrovich Rikhter," E. Kling, V. Novikov, K. Sukhorukov, Moscow, $6\frac{1}{2}$ pp

"Botan Zhur" Vol XXXIII, No 1 p. 116-122

Summarizes career of famous botanist and physiologist (1871 - 1947). Lists published work. Includes photograph.

36/49T40

KLING, F.O.

Gladiolus

Gladiolus is a saponin-bearing plant. Biul. Glav. bot. sada No. 10, 1951

Monthly List of Russian Accessions, Library of Congress, December 1952. UNCLASSIFIED

1. KLING, Ye G. - KRASNOVA, N.S.

2. USSR (600)

4. Gladiolus

7. Pre-sowing treatment of buds on gladiolus buds. Biul. Glav. bot. sada no.13 1952

9. Monthly list of Russian Accessions, Library of Congress, March 1953, Unclassified

KLING, Ye.G.

Physiology of plants in alkali soils. Biul.Glav.bot. sada no.18: 59-73 '54. (MIRA 8:3)

1. Glavnyy botanicheskiy sad Akademii nauk SSSR.
(Plants, Effect of salts on)

APPROVED FOR RELEASE: 09/18/2001 CIA-RDP86-00513R000723130007-8"

KLING, Ye.G.

Fusarium yellow rot of gladiolus. Biul.Glav.bot.sada no.19: 102-114 '54. (MIRA 8:2)

1. Glavnyy botanicheskiy sad Akademii nauk SSSR.
(Gladiolus--Diseases and pests)

KLIMO, Ye.G.

Biochemistry of Montbretia. Biul.Glav.bot.sada no.22:99-101 '55.
(MLRA 9:5)

1. Glavnyy botanicheskiy sad Akademii nauk SSSR.
(Tritonia)

KLING, Ye.G.

Physiology of gladioli in the yellows disease. Biul. Glav. bot. sada no.30:72-77 '58. (MIRA 11:6)

1.Glavnyy botanicheskiy sad Akademii nauk SSSR.
(Gladiolus--Diseases and pests)

KLIMO, Ye.G.

Wilt disease of lilacs; preliminary report. Biul. Glav. bot. sada no.42:84-90 '61. (MIRA 17:3)

1. Glavnyy botanicheskiy sad AN SSSR.

KLING, Z

KLING Carbonisation

205. GAS COALS FOR DILUTING HIGH QUALITY COAL BLENDS.

Czyzewski, M., Brtus, F. and Kling, Z. (Prace GIHO (Contr. Chief Inst. Metallurg. Found.), 1952, vol. 4, [illegible]). The literature on down grading coal charges for coking is surveyed. The blends investigated were composed of coking coals enriched by good coking coal and down graded by gas coal. The suitability of these blends for coking was investigated by the observations of the yields of water, tar, and gas. Laboratory and pilot plant coking experiments were made. The results showed that some coking coals can be used in blends but only in amounts not exceeding 10% of the charge. Coals yielding large quantities of tar at the end of the plastic period are the best for blending purposes. I.S.I.

KLING, Z.

Polish Technical Abst.
No. 1 1954
Minning

(1) Inilo

1/464 662.74.001.5

Czyzewski M., Byrtus F., Kling Z. Flame Coal as a Leaning Factor in Refined Coal Blends.

„Węgle płomienne jako środek odchudzający uszlachetniane mieszanki węglowe". (Prace Inst. Metalurgii No. 6), Katowice, 1953, PWT, 105 pp., 12 figs., 11 tabs.

Determination of the effect of blends leaned, by adding flame coal, on the quality and mechanical properties of coke. Method used in the investigations, and the authors' own experiments over degassing flame coal, blend coal, and blends used in coking tests; laboratory and box coking tests of blends to which flame coal was added. It was ascertained that flame coal which yields large quantities of tar at the end of the plasticity period is the most suitable for leaning blends.

L 45473-66

ACC NR: AT6033352 SOURCE CODE: HU/2505/65/026/01-/0103/0104

21
B+1

AUTHOR: Pickenhain, L.; Klingberg, F.

ORG: Department of Clinical Neurophysiology, Neuropsychiatric Clinic, Karl Marx University, Leipzig

TITLE: Changes in EEG, cortical evoked potentials and startle reactions in rats during the development of a conditioned avoidance reflex [Paper presented at the symposium of the Hungarian Physiological Society held in Budapest from 2-3 July 1963]

SOURCE: Academia scientiarum hungaricae. Acta physiologica, v. 26, no. 1-2, 1965, 103-104

TOPIC TAGS: EEG, rat, conditioned reflex, neurophysiology

ABSTRACT: The experimental method used and the results obtained are described briefly. It is concluded that in all situations which have the character of novelty (essential changes of the situation or motor acts that have not yet become automatized), the evoked potentials, especially their positive components, and the startle reactions are decreased. When the situation has lost its novelty and the acting stimulus has gained a signal meaning (i.e. in the initial phase of the conditioned reflex), or the signal meaning has already changed (i.e. during the extinction), the evoked potentials and the startle reaction increase. [Orig. art. in Eng.] [JPRS]

SUB CODE: 06 / SUBM DATE: none

Card 1/1 fv

0920 1374

PICKENHAIN, L.; KLINGBERG, F.

Changes in ECG, cortical evoked potentials and startle reactions in rats during the elaboration of a conditioned avoidance reflex. Acta physiol. acad. sci. Hung. 26 no.1:103-104 '65

1. Department of Clinical Neurophysiology, Neuro-Psychiatric Clinic, Karl Marx University, Leipzig, GDR.

KLINGBERG, F.; PICKENHAIN, L.

On the role of the hippocampus in the elaboration of conditioned escape reflexes in the rat. Acta physiol. acad. sci. Hung. 27 no.4:359-374 '65.

1. Abteilung fuer Klinische Neurophysiologie, Neurologisch-Psychiatrische Klinik der Karl-Marx-Universitaet, Leipzig, DDR.

HUNGARY

KLINGBERG, Fritz, of the Clinic for Neurology and Psychiatry at Karl Marx University (Neurologisch-Psychiatrische Klinik, Karl-Marx Universitat) in Leipzig, Germany, and GRASTYAN, Endre, of the Institute for Biology at the Medical University (Orvostudomanyi Egyetem Elettani Intezete) in Pecs.

"Changes of Optic-Evoked Potentials During Conditioning and Their Relation to the Conditional Startle Reaction"

Budapest, Acta Physiologica Academiae Scientiarum Hungaricae, Vol 23, No 2, 1963, pp. 115-135.

Abstract: [English article; authors' English summary] Similarly to sound stimuli, startle reactions are elicited by conditional light stimuli in an early phase of development of the conditional adversive reflex. At the time of appearance of the startle reactions, general motor inhibition, a decreased cortical electrical tone, and an increase of the late-surface negative waves of the evoked potential can be observed. It is suggested that a common mechanism is represented by this

1/2

PICKENHAIN, Lothar, and KLINGBERG, Fritz, Department of Clinical Neurophysiology at Karl Marx University (Karl-Marx-Universitat, Abteilung for Klinische Neurophysiologie) in Leipzig.

"Characterization of Differential Stages of Growth in the Rat with the Aid of Electrophysiological and Behavioral Data"

Budapest, Acta Physiologica Academiae Scientiarum Hungaricae, Vol 29, No 3-4, 8 Jun 1966, pp 253-259.

Abstract: [German article] Systematic electrophysiological and behavioral studies were conducted on over 100 unrestrained rats equipped with implanted epidural and subcortical electrodes with motorially predicated defense and nutritional reflexes. The various growth stages could be related to data on electrocardiogram desynchronization degree, amplitude of the evoked potentials, number of photic afterdischarges in the visual cortex, presence and frequency of the reflex in the dorsal hippocampus, respiration rate, and number of startle reflexes. Four principal stages were characterized. 13 references, including 2 Hungarian, 3 German, and 8 Western. (Manuscript received 3 Aug 1965).

1/1

laxed attention. The data obtained were presented and discussed in some detail. 15 references, including 5 Hungarian, 2 German, and 8 Western. (Manuscript received 3 Aug 1965).

KLINGEN, Ivan Nikolayevich; DUNIN, M.S., prof., doktor sel'skokhoz.nauk, red.; BOYARSKAYA, L.S., red.; ZUBRILINA, Z.P., tekhn.red.

[Among the patriarchs of agriculture of the Near and the Far Eastern people; Egypt, India, Ceylon, China] Sredi patriarkhov zemledeliia narodov Blizhnego i Dal'nego Vostoka; Egipet, Indiia, TSeilon, Kitai. Moskva, Gos.izd-vo sel'khoz.lit-ry, 1960. 603 p. (MIRA 13:11)

(Far East—Agriculture) (Near East—Agriculture)

KLINGER, Andras, dr.

The fourth session arranged by the Census Group of the Conference of European Statisticians. Stat szemle 37 no.3:313-323 Mr '59.

APPROVED FOR RELEASE: 09/18/2001 CIA-RDP86-00513R000723130007-8"

ACSADI, Gyorgy, dr; KLINGER, Andras, dr.;

Results of family planning and birth control surveys.
Stat szemle 41 no.3:227-258 Mr '63.

1. Kozponti Statisztikai Hivatal osztalyvezetohelyettese (for Acsadi).
2. Kozponti Statisztikai Hivatal foosztalyvezetohelyettese (for Klinger).

KLINGER, B.Sh.; TRUSOVA, M.A.

First find of fossil flora in Zhideliasy sediments of Dzhezkazgan District. Mat.po geol.i pol.iskop.TSentr.Kazakh. no.2:21-22 '62. (MIRA 15:12)

(Dzhezkazgan District—Paleobotany, Stratigraphic)

KLINGER, Endre, dr

A method of preparing abutment teeth by axis deviation. Fogorv. szemle 47 no.7:232 July 54.

1. A Fogaszati Tovabbkepzo Itezetbol. (Vezeto foorvos: Kende Janos dr)

(DENTAL PROSTHESIS,
abutment teeth, prep. by axis deviation)

KLINGER, G.K.

KASPER, M.A., jt. au.

Experience of introducing precision founding in the Minsk Motorcycle Factory. Minsk, Gos. izd-vo BSSR, 1954. 22 p. Bibliotechka novatora. (55-30635)

T3236.K55

APPROVED FOR RELEASE: 09/18/2001 CIA-RDP86-00513R000723130007-8"

KLINGER, H.

Radio astronomy. p. 269. TERMESZET ES TARSADALOM. (Tarsadalom- es Termeszettudomani Ismeretterjeszto Vallalat) Budapest. Vol. 114, no. 5, May 1955. From Lenin's legacy; Lenin's guidance for workers in cultural propaganda work. p. 257.

SOURCE: East European Accessions List (EEAL), Library of Congress Vol. 5, no. 6, June 1956.

KLINGER, M. I.

USSR/Physics - Semiconductors FD-615

Card 1/1 : Pub. 146-5/18

Author : Klinger, M. I.

Title : Investigation of the energy spectrum of an electron in an ionic semiconductor in the presence of electric and magnetic fields

Periodical : Zhur. eksp. i teor. fiz. 26, 159-167, February 1954

Abstract : Investigates the energy spectrum of an electron which is interacting with optical oscillations of an ionic semiconductor, under the application of mutually perpendicular electric and magnetic fields. It is found that the effective mass of the conductor depends on the electric and magnetic fields as well as on the temperature. Examines the question of the distribution of phonons according to momentum. Thanks Prof A. G. Samoylovich and S. V. Tyablikov.

Institution : Chernovtsy State University

Submitted : July 19, 1953

USSR/Physics - Semiconductors FD-616

Card 1/1 : Pub. 146-6/18

Author : Klinger, M. I.

Title : Investigation of a polaron semiconductor in the presence of electric and magnetic fields

Periodical : Zhur. eksp. i teor. fiz. 26, 168-172, February 1954

Abstract : Investigates the self-adjusted ground state of a polaron in the presence of mutually perpendicular electric and magnetic fields. Examines the question of the "breaking" of a polaron excited by the electric field. Thanks Prof. A. G. Samoylovich and Prof. S. I. Pekar for their assistance and suggestions.

Institutions : Chernovtsy State University

Submitted : July 18, 1953

Klinger, M.I.

The theory ... M. I. Klinger

C-3

KLINGER, M.I.

USSR/Electricity - Semiconductors

Abs Jour : Ref Zhur - Fizika, No 3, 1957, No 7012

Author : Klinger, M.I.
Title : Concerning the Theory of the Hall Effect in Ionic Semiconductors

Orig Pub : Zh. eksperim. i teor. fiziki, 1955, 29, No 4, 439-448

Abstract : The Hall constant in an ionic semiconductor is calculated by the method of stationary states, i.e., without using the kinetic equation. This makes it possible to take into account the quantization of the carrier energy in the magnetic field. Account is taken of the interaction between the electrons and the polarization oscillations of the lattice (case of weak and adiabatic coupling are considered). In impurity semiconductors (when carriers of one sign predominate) the results (in the weak coupling method) turn out to be the same as in the ordinary scheme with the kinetic equation (if one foregoes the "polaron" corrections); but if the conductivity is made mixed, there is a rather substantial difference from the kinetic theory. In particular, in a polaron semiconductor the sign of the Hall constant is determined in this case by the ratio of the polarizabilities of the electron and hole polarons.

Card : 1/1

KLINGER, M.F.

G

USSR / Electricity

Abs Jour : Ref Zhur - Fizika, No 4, 1957, No 9727

Author : Klinger, M.I., Chaban, M.M.
Inst : Not given
Title : Concerning the Problem of the Faraday Effect in Semiconductors

Orig Pub : Zh. tekh. fiziki, 1956, 26, No 5, 938-940

Abstract : When electromagnetic waves pass througha semiconductor placed in a magnetic field (H), the plane of polarization is rotated. The angle of rotation θ, called the Faraday angle, is $\theta = VlH$, where l is the thickness of the specimen and V is the Verdet constant. $V = \frac{4\pi R\sigma^2}{n c}$

Here R is the Hall constant, σ is the electric conductivity, and n the index of refraction. This formula takes into account only the rotation of the plane of polarization by free carriers. The rotation of the lattice itself is appa-

Card : 1/2

USSR / Electricity G

Abs Jour : Ref Zhur - Fizika, No 4, 1957, No 0727

Abstract : rently much weaker. An estimate of the value of V shows that, for example, for n-Ge in the case of carrier concentration n 10^{16} cm^3 V = 2 x 10^{-2}, i.e., at H = 10^4 gauss and 1 = 10^{-4} cm we get θ = approximately 1°, i.e., this effect can be measured. It is proposed to employ the Faraday effect for the determination of the temperature dependence of the mobility and to calculate the effective mass of the carriers.

CArd : 2/2

KLINGER, M.I.

CARD 1 / 2 PA - 1579

SUBJECT USSR / PHYSICS
AUTHOR KLINGER, M.I., NOVIKOVA, V.G., AGARKOVA, V.N.
TITLE On the Theory of the HALL- and NERNST Effects in a Semiconductor with an Admixture Zone.
PERIODICAL Žurn.techn.fis, 26, fasc.10, 2185-2194 (1956)
Issued: 11 / 1956

The present work is a continuation of that by A.G.SAMOJLOVIČ and M.KLINGER, Žurn.techn.fis, 25, 12, 2050 (1955) and investigates the HALL effect in a semiconductor with narrow (donorlike) admixture zone with univalent admixture. However, at first the same effect is investigated for a metal with narrow conductivity zone. HALL'S constant R of such a metal is derived by means of the general formula for any dispersion law of the energy of an electron. A simple cubic atomic lattice is assumed on this occasion. With $n/n_o > 1$ and $n/n_o < 1$ R is positive or negative respectively. HALL'S constant is then determined by the holes or by the electrons respectively. If $n = n_o$ (i.e. if the zone is half filled up) $R = 0$. Here n denotes the number of electrons in the narrow zone and n_o the density of the atoms in the lattice corresponding to the narrow zone. Now the constant R of a semiconductor with a narrow admixture zone is computed for the case of two zones. In the case of electronic conductivity in both zones it is true, as expected, that $R(T) < 0$. Naturally, the results obtained here hold also if the valence zone and the acceptor admixture zone are

PA - 2025

AUTHOR: KLINGER, M.I.
TITLE: On the Theory of Galvanomagnetic Phenomena in Semiconductors.
PERIODICAL: Zhurnal Eksperimental'noi i Teoret.Fiziki, 1956, Vol 31, Nr 6, pp 1055-1061 (U.S.S.R.)
Received: 1 / 1957 Reviewed: 3 / 1957

ABSTRACT: The same author made the attempt in a previous work (Zhurnal Eksperimental'noi i Teoret.Fiziki, 1955, Vol29, Nr 439) to apply the computation method of S.TITEICA (Ann.d.Phys.22,129 (1935)) for the computation of the isothermal HALL effect and of the resistance in a transversal magnetic field. This method makes it possible to take the quantisation of the energy spectrum of the current carriers into account. The present work investigates the application of this method in the case of the computation of the resistance of a semiconductor and of HALL'S constant in a strong transversal magnetic field. Several alleged deficiencies of TITEICA'S work are pointed out. The object of the investigation is a current carrier which moves in a solid body in the presence of electric and magnetic fields which are vertical to one another and enters into interaction with the phonons. The crossed electric and magnetic fields ($E \perp H$) change the spectrum of the current carrier, so that the energy of the current carrier (in consideration of electron spin) is determined by the following expression:

Card 1/3

PA - 2025

On the Theory of Galvanomagnetic Phenomena in Semiconductors.

$$\mathcal{E}_{Q\pm} = P_z^2/2\mu + \hbar\omega_o(n + 1/2) + eE\,x_o \pm \mu_B H$$

$n = 0,1,2,\dots$; $\omega_o = eH/\mu c$; $x_o = -P_y/\mu\omega_o - eE/\mu\omega_o^2$

Here x_o denotes the center of the oscillator, μ_B - BOHR'S magneton, μ - the effective mass of the corresponding quasi-particle. As, when applying the fields, the motion of the current carrier becomes anisotropic, it is necessary to introduce the tensors $\sigma_{ik}(H)$ $(i,k=1,2,3)$ and $\varrho_{ik}(H)$ of electric conductivity into the investigation. It applies in this case that $\sigma_{13} = \sigma_{23} = \varrho_{13} = \varrho_{23} = 0$.

The HALL effect and the electric resistance in a strong transversal magnetic field in semiconductors. The amperage j_y in an unlimited gyrotropic medium can be computed in a general case as follows: a) By computing $\hat{v}_y = [y\,\mathcal{H}]$, where $\mathcal{H}$ denotes the HAMILTONIAN of the system in the case of crossed fields, b) By means of the density matrix $\hat{\varrho}$ belonging to $\mathcal{H}$ the amperage $j_y = |e|\,Sp(\hat{\varrho}\hat{v}_y)$ is determined. In the simplest case, in which

Card 2/3

K[illegible]NGER, M.I.

APPROVED FOR RELEASE: 09/18/2001 CIA-RDP86-00513R000723130007-8"

KLINGER, M. I.

APPROVED FOR RELEASE: 09/18/2001 CIA-RDP86-00513R000723130007-8"

AUTHORS: Klinger, M. I., Voronyuk, P. I. 57-27-7-33/40

TITLE: Galvanomagnetic Phenomena in n-Ge or n-Si Monocrystals in Strong Magnetic Fields (Gal'vanomagnitnyye yavleniya v monokristalle n-Ge ili n-Si pri sil'nykh magnitnykh polyakh).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1957, Vol. 27, Nr 7, pp. 1609-1613 (USSR)

ABSTRACT: The electric resistance ϱ_H in a transverse magnetic field H and the Hall-constant R in strong fields H in a monocrystal of the type n-Ge or n-Si are investigated here. The conductivity-electron in Ge or Si is a quasi-particle with an anisotropic mass (m_1 - transverse mass, m_2 - longitudinal mass), its surfacesof the constant energy are ellipsoids of revolution of which eight are present in Ge and six in Si. In a magnetic field the energy-spectrum of these conductivity-electrons is quantised and in sufficiently strong H this effect plays an important part. In the calculation ϱ_H and R this effect and the anisotropic character of the electron-mass (in the present paper) are taken into account.

Card 1/3

Galvanomagnetic Phenomena in n-Ge or n-Si Monocrystals in Strong Magnetic Fields 57-27-7-33/40

It is shown that Q_H and R rapidly increase with increasing $\frac{H}{T}$, just as in an isotropic case. What is new in comparison with an isotropic case is that the quantities N, R and Q_H are highly anisotropic. N - the electron-number density of the ellipsoid. It is shown that the anisotropy of the quantities Q_H and R is the distincter the higher the anisotropy of the mass

$$\varrho = \frac{m_2}{m_1}$$

But as the anisotropy N (H, T) is the determinent element, not only Q_H and R but also other equilibrated kinetic coefficients are exponentially anisotropic.
There are 4 references, 3 of which are Slavic.

Card 2/3

Galvanomagnetic Phenomena in n-Ge or n-Si Monocrystals in Strong Magnetic Fields 57-27-7-33/40

ASSOCIATION: Institute for Semiconductors AS USSR; State University of Chernovtsy (Institut poluprovodnikov AN SSSR, Chornovitskiy gosudarstvennyy universitet).

SUBMITTED: January 28, 1957

AVAILABLE: Library of Congress

1. Single crystals-Electrical properties 2. Germanium-Electrical properties 3. Silicon-Electrical properties

Card 3/3

KLINGER, M.I.

Low temperature anomalies in impurity semiconductors. Zhur.tekh.fiz. 27 no.8:1915-1919 Ag '57. (MIRA 10:9)

1. Institut poluprovodnikov Akademii nauk SSSR, Leningrad.
(Semiconductors) (Low temperature research)

KLINGER, M.I.

57-8-36/36

AUTHOR Klinger M.I.

TITLE Remarks on the Low-Temperature Anomalies in the Impurity Semi-conductors.II.
(K voprosu o nizkotemperaturnykh anomaliyakh v primesnykh polu-provodnikakh.II. - Russian)

PERIODICAL Zhurnal Tekhn.Fiz.,1957,Vol 27,Nr 8,pp 1919-1922 (U.S.S.R.)

ABSTRACT First the equation for exp (see work of same author in T,1957 Vol 27,p 271,formula (8)) is deduced. A hole-semiconductor with n_d monovalent donor centers per cbcm and with n_a acceptors is investigated, $n_d < n_a$ being assumed as ever. After this the author compares the results of his work mentioned above with the experiments of Fritzsche, L.Horovitz (Phys.Rev. 99,400,1955) and he shows that the linear dependence $\frac{\Delta\varrho}{\varrho H}$ on H/T found out in their work does not contradict the formula (9) obtained by himself. He points at the still unsolved problem, why in p- and n-Germanium $\frac{\Delta\varrho}{\varrho} \sim H^2$ in the case of low T (and great $\frac{H}{T}$) with the increase of $\frac{1}{T}$, and why it decreases to very small values but still remains positive. Some unconsidered circumstances are mentioned which influence this phenomenon and which still have to be investigated exactly. (2 Slavic references)

Card 1/2

Remarks on the Low-Temperature Anomalies in the Impurity Semiconductors.II. 57-8-36/36

ASSOCIATION Leningrad Institute for Semiconductors of the Academy of Sciences of the U.S.S.R.
(Institut poluprovodnikov AN SSSR,Leningrad).

SUBMITTED January 28, 1957

AVAILABLE Library of Congress.

Card 2/2

KLINGER, M. I.

57-10-13/33

AUTHORS: Klinger, M. I., and Zosulya, Yu. I.

TITLE: Contribution to the Theory of Semiconductors with the Excited Impurity Zone (K teorii poluprovodnikov s vozbuzhdennoy primesnoy zonoy).

PERIODICAL: Zhurnal Tekhn. Fiz., 1957, Vol. 27, Nr 10, pp. 2285-2290 (USSR).

ABSTRACT: The electric properties of a semiconductor with a fundamental impurity level and an excited impurity zone are investigated. The electric conductivity σ, the Hall constant R, and the thermoelectromotive force α were investigated. On the strength of the investigation following can be said. 1) $\bar{u}$ (T), σ (T), R (T), and α(T) of a semiconductor with an excited impurity zone behave qualitatively like a semiconductor with a fundamental impurity zone if T is changed. The taking into account of the impurity zone which is more excited than the p-zone in the case of existence of not split up deeper lying impurity zones leads qualitatively to the same results. On the other hand the temperature distribution of σ (T) and R (T) is qualitatively similar to that of σ (T) and R (T) in Ge at low T obtained by H. Fritzsche and K. Lark-Horovitz (Physica, XX, 834, 1954). 2) The impurity concentration in the Ge-sample used by

Card 1/3

Contribution to the Theory of Semiconductors with the Excited Impurity Zone. 57-10-13/33

Fritzsche and Lark-Horovitz is low: $n_o \sim 10^{15} cm^{-3}$. n_o is the impurity concentration. If, however, the anisotropy of the electronic mass m_{ik} and the anisotropy of the dielectric constant ε_{ik}, and especially the fact that the excited impurity zone leads to similar results in the paper of F-L-H is taken into consideration, it becomes obvious why already at n_o 10^{16} in Ge at low T the influence of the impurity zone is exercised. This is even the case if it is assumed that the impurity atoms form almost in the fundamental lattice a kind of superstructure - an impurity lattice. Therefore the Authors are of the opinion that on the strength of the mentioned paper by Fritzsche one cannot draw the conclusion that an impurity lattice does not exist and that the impurity atoms are statistically distributed in the fundamental lattice. There are 3 figures and 2 Slavic references.

ASSOCIATION: Chernovtsy State University (Chernovitskiy gosudarstvennyy universitet).

Card 2/3

Contribution to the Theory of Semiconductors with the Excited Impurity Zone. 57-10-13/33

SUBMITTED: October 5, 1957.

AVAILABLE: Library of Congress.

Card 3/3

KLINGER, M. I.

AUTHOR: Klinger, M. I. 57-12-12/19

TITLE: Remarks on the Theory of Transfer Phenomena (K teorii yavleniy perenosa).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1957, Vol. 27, Nr 12, pp. 2780-2783 (USSR)

ABSTRACT: Reference is made to the papers by Kubo, Nakadsima and Tomita (reference 1), who, starting from the equations of motion of the matrix of the density ϱ, have advanced another step in comparison to Boltzmann's equation. The general formulae for the tensors, which characterise the differential electromotive force, the Peltier heat and the heat conductivity are obtained here in the same way as the general formula for the tensor of electric conductivity is obtained in the papers referred to. For this purpose, the gradients of temperature T (or $\beta = \frac{1}{kT}$) and of the chemical potential μ (or $\frac{u}{kT} \equiv \zeta$) are introduced into the equations of motion of ϱ, applying the method proposed by Samoylovich and Korenblit (reference 5). This is conducted in the case, where the system (i.g. the electron- and phonon-field in

Card 1/4

interaction with each other) is expressed by fields, which interact by means of a repeated quantization. On the occasion of the deduction of the formulae for $A\omega$ and $B\omega$ it appears, that an effect is automatically taken into consideration, which up to now had never been investigated. This effect consists in the following circumstances if, for the sake of simplicity, an admixture-semiconductor is considered. On the Assumption, that the conduction zone represents an ionization-continuum of the electron of the admixture atom, the operator of the electron field Ψ is obtained. In this case H_{int} consists of three terms, of which $H^{(1)}_{int}$ represents the interaction, $H^{(2)}_{int}$ the virtual transitions of electrons from the admixture level into the zone and vice versa under the influence of the interaction with the phonones, and $H^{(3)}_{int}$ the virtual transitions between the admixture levels of the admixture. It can be shown, that $H^{(3)}_{int}$ furnishes no contribution towards σ, but contributes

toward $\alpha_{\mu\nu}$, $\varkappa_{\mu\nu}$ and $K_{\mu\nu}$. The $H^{(2)}_{int}$ operator contributes towards $\sigma_{\mu\nu}$ (and towards $\alpha_{\mu\nu}$, $\varkappa_{\mu\nu}$, $K_{\mu\nu}$, of course). The $H^{(0)}_{int}$ operator contributes toward $\sigma_{\mu\nu}$, and towards $\alpha_{\mu\nu}, \varkappa_{\mu\nu}, K_{\mu\nu}$, of course). An immediate computation shows, that $H^{(2)}_{int}$ leads to a reduction of the electric conductivity $\sigma_{\mu\nu}$. If the valence-zone is taken into consideration, corresponding contributions towards T, Hint and $\sigma_{\mu\nu}$ appear. The paper was discussed with Professor A. G. Samoylovich and L. L. Korenblit. After this paper had gone to the press already, the author obtained knowledge of the paper by Nakano in Progr.theor.phys., 17, 145, 1957. It is pointed, to the circumstance, that the author does not consent with Nakano's deduction of σ. Moreover, it is shown, that the final equation for σ obtained by Nakano can be deduced from the formula for $\sigma_{\mu\nu}$, if the exponential function (eksponenta) in the integral with respect to $d\tau$ is replaced by its asymptotic value for $\tau \rightarrow \infty$ at all values of τ. Such an approximation, however, can not be considered to be justified, because in the case of small τ the relation

Card 3/4

Remarks on the Theory of Transfer Phenomena 57-12-12/12

may be quite different. In this approximation the contribution of the virtual processes is not taken into consideration. There are 6 references, 3 of which are Slavic.

ASSOCIATION: Institute for Semiconductors AN USSR, Leningrad (Institut poluprovodnikov AN SSSR Leningrad)

SUBMITTED: April 20, 1957

AVAILABLE: Library of Congress

Card 4/4

KLINGER, M. I.

AUTHORS: Samoylovich, A. G., Klinger, M. I., Nitsovich, V. M. 57-12-13/19

TITLE: On the Correlation Between the Electrons in Narrow Admixture Zones of Semiconductors (O korrelyatsii mezhdu elektronami v uzkikh primesnykh zonakh poluprovodnikov).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1957, Vol. 27, Nr 12, pp. 2784-2785 (USSR)

ABSTRACT: In this paper, the influence of the correlation between the electrons on the electron distribution in a narrow admixture zone and on the electron distribution according to quasi-momenta. The investigation is started from the assumtion, that only electrons situated in one admixture centre may interact with each other. From the result obtained, (equation) it can be seen, that in the case of $A^{*} = 0$ (no correlation) the ordinary statical formulae by Fermi-Dirac (with an exactitude including A^{*2}) are obtained. In the case of $A^{*} \to \infty$, (infinite correlation, implying the absolute impossibility of finding two electrons in one admixture atom) a further formula is deduced from the former one. The formulae deduced here, show, that the correlation

Card 1/2

On the Correlation Between the Electrons in Narrow Admixture Zones of Semiconductors 57-12-13/19

between the electrons leads to a considerable scattering of the electrons within the zone and promotes the occurrence degeneration. A more exact investigation of the influence of the correlation between electrons on the kinetics of processes in the narrow admixture zone will be conducted by V. M. Nitsovich in another place.

ASSOCIATION: Institute for Semiconductors AN USSR, Leningrad (Institut poluprovodnikov AN SSSR Leningrad)

SUBMITTED: March 27, 1957

AVAILABLE: Library of Congress

Card 2/2

KLINGER, M.I.; VORONYUK, P.I.

Magnetoresistive phenomena in n-GE type semiconductors located in strong magnetic fields [with summary in English]. Zhur. eksp. teor. fiz. 33 no.1:77-87 Jl '57. (MIRA 10:9)

1. Chernovitskiy gosudarstvennyy universitet i Institut poluprovodnikov Akademii nauk SSSR.

(Semiconductors--Magnetic properties)
(Hall effect)

KLINGER, M.I.

AUTHOR: Klinger, M.I. 56-2-10/47

TITLE: On the Magnetic Susceptibility of Semiconductors with an Admixture Zone in a Strong Magnetic Field. (Magnitnaya vospriimchivost' poluprovodnika s primesnoy zonoy v sil'nom magnitnom pole)

PERIODICAL: Zhurnal Eksperim. i Teoret. Fiziki, 1957, Vol. 33, Nr 2(8), pp. 379-386 (USSR)

ABSTRACT: The paper under consideration shows, that the magnetic susceptibility in strong magnetic fields $\vec{H}$ is the most suitable quantity for the investigation of the admixture zones, of the dispersion law and the position of the corresponding admixture atoms in the principal lattice. On this occasion the author limits himself to the consideration of the simplest type of semiconductors. In its energy spectrum the conduction zone and the main admixture zone are considered, (in the case of a hole-semiconductor: the valence zone and the acceptor -admixture zone). The admixture is here supposed to be univalent, its concentration is denoted by n_0. The distance $\Delta\mathcal{E}$ between the bottom of the conduction zone and the ceiling of the admixture zone is here considered to be positive. Because of the narrow placement of the admixture zones the deviation of the dependency of the electron energy $\mathcal{E}(k)$ on the vector $\vec{k}$ from the square function must be taken into consideration. The author puts $\mathcal{E}(\vec{k}) = -\Delta\left[\cos k_x a + \cos k_y a + \cos k_z a\right]$. The admixture atoms are supposed to be in a simple principal lattice with the lattice constant a in the main semiconductor $a = n_0^{-1/3}$.

Card 1/2

KLINGER, M.I.

AUTHOR KLINGER, M.I., VORONYUK, P.I. 56-7-13/66

TITLE ~~Magnetoresistive~~ Phenomena in n-Ge Type Semiconductors located in Strong Magnetic Fields.
(Gal'vanomagnitnyye yavleniya pri sil'nykh magnitnykh polyakh v poluprovodnikakh tipa n-Ge.- Russian)

PERIODICAL Zhurnal Eksperim. i Teoret. Fiziki 1957, Vol 33, Nr 7 pp 77-87 (USSR)

ABSTRACT The present paper investigates the equilibrium concentration of the electrons, HALL'S constant, and the electrical resistance in semiconductors of the type of n-Ge in the presence of a strong magnetic field. Here the anisotropy of the mass of the electron in strong magnetic fields is taken into account.
The computation of current intensity: The electric $\vec{E}$ is assumed to be directioned along the X-axis and the vertical magnetic field $\vec{H}$ along the Z-axis. The author here computes the components of the electric current intensity $\vec{j}$ for crossed electric and magnetic fields by the method of steady states. For this purpose the energy spectrum of the electron with anisotropic mass has to be determined. As a mechanism for the scattering of electrons the interaction of an electron with a longwaved longitudinal acoustic phonon is investigated.

CARD 1/2

AUTHORS: Klinger, M. I., Makarycheva, G. A. 57-2-13/32

TITLE: On the Theory of Semiconductors With an Excited Impurity Zone (K teorii poluprovodnikov s vozbuzhdennoy primesnoy zonoy).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 2, pp. 264-266 (USSR).

ABSTRACT: This is a letter to the editor. The investigation is based on the results of reference 1. Only the excited impurity-p-zones are taken into account here. It is examined which part they play in the electric conductivity σ, in the Hall effect and in the thermo-electromotive force α. The law of dispersion in the ground-impurity-1s-zone and in the excited p-zones is the same as in references 2 and 3, the designations also all remain the same as in references 2 and 3. It is shown that in all cases the following tendency prevails: on approach of the ground of the p-zones to the center of the 1s-zone the level $\mu(T)$ at identical T decreases. In the calculation of $\sigma(T)$ and $R(T)$ with the aid of known $\mu(T)$ the following results were obtained. 1.) With a rise in T, $\sigma(T)$ in the total interval T decreases just like in the absence of the excited impurity-zones. When these zones are taken into account the decrease takes place slowlier: the excited zones which are somewhat wider than the ground

Card 1/4

On the Theory of Semiconductors With an Excited Impurity Zone. 57-2-13/32

zone represent traps for the electrons. 2.) The concentration of the current-carriers in the p-zones first increases with an increase in T and then decreases. 3.) In all cases applies $R(T) < 0$ and $R_{1s} < 0$, $R_{1p} < 0$, $R_{3n} < 0$. In the case of small $\Delta_2 \varepsilon$ (case I, II, III) $|R(T)|$ slowly increases with an increase in T, as far as the electrons of the conductivity-zone play an important part in the case of small $\Delta_2 \varepsilon$. But in the case of higher $\Delta_2 \varepsilon$ (case IV and V) the course with temperature of $|R(T)|$ becomes more complicated: $|R(T)|$ represents a curve with a number of maxima and minima which is apparently to be explained by the complicated interaction of the electron-concentrations in the 1s- and p-zones, as well as by the fact that in the case of high $\Delta_2 \varepsilon$ in the conductivity-zone, even at T = 400°C (as shown by the calculation), few electrons occur and the p-zones are effective electron-traps. As far as $\alpha(T)$ is concerned it depends, like in references 2 and 3, on T, mainly as $\tilde{\mu}(T)$.

$$\alpha \simeq \frac{k\pi}{e} \tilde{\mu}$$

Card 2/4

The quantity $\Delta(T)$ was here graphically determined for the following 5 cases:

I. $\Delta_1 \varepsilon = 0{,}002$ eV.

II. $\Delta_1 \varepsilon = 0$,

III. $\Delta_1 \varepsilon = -0{,}002$ eV, $\Delta_2 \varepsilon = 0{,}005$ eV, $\Delta = 0{,}0025$ eV, $\gamma = 0{,}005$ eV, $\beta = 0{,}015$ eV.

IV. $\Delta_1 \varepsilon = 0{,}005$ eV.

V. $\Delta_1 \varepsilon = -0{,}01$ eV.

$\Delta_2 \varepsilon = 0{,}06$ eV, $\Delta = 0{,}008$ eV, $\beta = 0{,}02$ eV, $\gamma = 0{,}01$ eV.

$D_1 = 6\Delta$, $D_2 = 4\beta + 2\gamma$.

The negative $\Delta_1 \varepsilon$ signify that the ground- and the excited impurity-zone overlap.

Professor A. G. Samoylovich showed interest in this work.

There are 4 figures, and 3 references, 2 of which are Slavic.

On the Theory of Semiconductors With an Excited Impurity Zone.

57-2-13/32

ASSOCIATION: Institute of Semiconductors AS USSR, Leningrad (Institut poluprovodnikov AN SSSR, Leningrad).

SUBMITTED: October 5, 1956.

AVAILABLE: Library of Congress.

1. **Semiconductors-Excitation** 2. **Crystals-Impurities**

Card 4/4

KLINGER, M.I.

Some properties of relaxation functions and kinetic coefficients. Fiz. tver. tela 1 no.4:674-678 '59. (MIRA 12:6)

1. Institut poluprovodnikov AN SSSR, Leningrad. (Mathematical physics)

KLINGER, M.I.

Statistical theory of the electric conductivity of semiconductors. Fiz. tver. tela 1 no.6:861-872 Je '59. (MIRA 12:10)

1. Institut poluprovodnikov AN SSSR, Leningrad.
(Semiconductors) (Electric conductivity)

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AUTHOR: Klinger, M. I.

SOV/181-1-8-12/32

TITLE: On the Statistical Theory of Kinetic Phenomena. II

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 8, pp 1225 - 1238 (USSR)

ABSTRACT: The author determines general expressions for the kinetic coefficients by solving the density matrix of a system that is under the action of generalized forces of the temperature gradient type. With the aid of these general expressions (which are calculated in the first part of the present paper) the author then deduces generalized formulas for the kinetic coefficients of a weak electron-phonon interaction. Next, electronic heat conductivity and thermoelectromotive force of semiconductors are investigated. The afore-mentioned generalized formulas hold, irrespective of the specific properties of the relaxation process. In the second part the author calculates in detail and step by step n-type conductivity and thermoelectromotive force in weak electron-phonon scattering. Finally, the following is summarized: 1) The author presents a new derivation of the non-equilibrium part $\rho'(t)$ of the density matrix of the system to which the electric field $\vec{E}$ is applied. On the basis of this derivation the author postulates the equation of

Card 1/3

9

67307

On the Statistical Theory of Kinetic Phenomena. II SOV/181-1-8-12/32

motion of the operator $\rho'(t)$, for the action on a system of small statistical and mechanic forces which are determined by the deviation of the macroparameters of the system from their equilibrium values. By solving these equations one obtains after some transformations the most general expressions for the mean current densities and the kinetic coefficients as well as some of their general properties. These most general expressions are considerably simplified if there is no outer constant magnetic field present. With a weak electron-phonon interaction formulas are deduced for the n-type heat conductivity and the thermoelectromotive force L in the second approximation of the perturbation theory. The results of this paper are compared with those of earlier papers. At the Third Conference on Semiconductors V. L. Bonch-Bruyevich put a paper by R. Zigenlaub at the disposal of the author, which was in print. The author thanks A. G. Samoylovich for his permanent interest in the present paper and for helpful discussions. It was submitted at the Third Conference on Semiconductor Theory held at

Card 2/3

4

67307

On the Statistical Theory of Kinetic Phenomena. II SOV/181-1-8-12/32

L'vov on April 5, 1959. There are 12 references, 7 of which are Soviet.

ASSOCIATION: Institut poluprovodnikov AN SSSR, Leningrad (Institute of Semiconductors of the AS USSR, Leningrad)

SUBMITTED: July 26, 1957 (initially), and November 3, 1958 (after revision)

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Card 3/3

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67394

SOV/181-1-9-12/31

AUTHOR: Klinger, M. I.

TITLE: On the Statistical Theory of Electrical Conductivity of Semiconductors. III

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1385 - 1392 (USSR)

ABSTRACT: The present paper investigates the electrical conductivity of impurity semiconductors by considering the transitions of electrons from the conduction band to impurity levels (de-ionization) and inversely (ionization) in their unelastic collisions with phonons. It is shown in this connection how new effects which do not appear in the equation of motion can be considered within the density matrix method. The description of the electron field in the semiconductor occurs here in second-quantization representation. The investigation is applied to the special case of an n-type donor semiconductor. After writing down the general equations the theoretical description is continued on the assumption that the concentration of the impurity centers be sufficiently small, so that certain neglects can be made. Among others, expressions for σ_1 and σ_2

Card 1/2

4

67394

On the Statistical Theory of Electrical Conductivity of Semiconductors. III SOV/181-1-9-12/31

are derived in second disturbance-theoretical approximation, with $I^{(1)}_{\mu} = \sigma_1 E_{\mu}$ and $I^{(2)}_{\mu} = \sigma_2 E_{\mu}$ ($I^{(1)}_{\mu}$ is the electron current in conduction, $I^{(2)}_{\mu}$ the electron current in transitions band ⇄ impurity level, E is the electric field). Next, the author investigates the influence exerted by the ionization of impurity electrons on the electrical conductivity of an ion crystal, with the electron gas being assumed to be not degenerated. There are 4 references, 3 of which are Soviet.

ASSOCIATION: Institut poluprovodnikov AN SSSR Leningrad (Institute of Semiconductors of the AS USSR, Leningrad)

SUBMITTED: July 26, 1957 (initially) and 1959 (after correction)

4

Card 2/2

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B006/B056

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AUTHOR: Klinger, M. I. [redacted]

TITLE: The Theory of the Piezoresistance in Bi_2Te_3

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 6, pp. 1353-1356

TEXT: The effect discovered by C. Smith in Ge and Si consists in the fact that the electric conductivity of the crystal changes as soon as a certain kind of homogeneous deformation voltage is applied to it. The theory of the piezoresistance developed in Ref. 2 is here applied to Bi_2Te_3 and it is investigated what knowledge may be obtained concerning Bi_2Te_3 from measurements of the piezoresistance. First, the general case is dealt with, in which the energy of the conduction electron has several (q) minima without a fixed configuration in the $\vec{k}$-space, and that electron transitions between these minima may be neglected. As shown by an estimation, the main effect leading to the occurrence of the piezoresistance in this case is concentration. In the deformation of the crystal, the shifting of the band

Card 1/3

edge differs with different minima, so that, consequently, the degree of the filling up of the regions of the $\vec{k}$-space near the various minima changes non-uniformly. The most-occupied minima make a larger contribution towards electric conductivity, i. e. the deformed crystal has an increased conductivity: $\sigma_{jl} = \sigma_{jl} + \delta\sigma_{jl}$, where σ_{jl} is the conductivity of the undeformed crystal. For the additional conductivity $\delta\sigma_{jl}$ expressions are derived. Formula (14) gives these expressions for the individual components as functions of the components of the tensor of the dielectric constant $\mathcal{E}_{kr}$ and the tensor of the constants of the deformation potential D^s_{kr} (of the s-th minimum). Formula (14) refers to the first minimum. In a general way (11) holds: $\delta\sigma_{jl} = \sum\limits_{k_1 r=1}^{3} G_{jl;kr}\mathcal{E}_{kr}$; $G_{jl;kr} = \beta \sum\limits_{s=1}^{q} (\bar{D}_{kr} - D^s_{kr})\sigma^s_{jl}$. The $G_{jl;kr}$ are individually determined by (15). If the masses m_1, m_2, and m_3 are known, it is possible, by using the results obtained in Ref. 3, to

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The Theory of the Piezoresistance in Bi_2Te_3 S/181/60/002/06/50/050
B006/B056

determine D^1_{kr}. The author finally thanks Professor A. G. Samoylovich and Professor A. R. Regel' for discussions. There are 3 references: 1 Soviet and 2 American.

ASSOCIATION: Institut poluprovodnikov AN SSSR Leningrad (Institute of Semiconductors of the AS USSR, Leningrad)

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Card 3/3

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AUTHOR: Klinger, M. I.

TITLE: Application of the Attenuation Theory to the Calculation of Kinetic Coefficients

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 12, pp. 3092-3105

TEXT: The attenuation theory proposed by L.van Hove in Ref. 3 is used to calculate kinetic coefficients in the absence or presence of a magnetic field. For the limiting case of weak interaction between carriers and scatterers, general and explicit expressions are obtained for the kinetic coefficients. In the important special case of elastic, anisotropic scattering which is characterized by the tensor of the relaxation time whose principal axes are arbitrarily directed relative to the principal axes of the effective mass tensor, concrete formulas are given for a large number of effects, such as the galvanomagnetic, the thermomagnetic, and the magneto-optical Faraday effect. Professor A. G. Samoylovich and V. L. Bonch-Bruyevich are thanked for discussions. There are 7 references: 5 Soviet, 2 British, 1 US, 2 Japanese, and 1 Dutch

Card 1/2

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Application of the Attenuation Theory to the Calculation of Kinetic Coefficients

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B006/B063

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Card 2/2

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24.5200(1164)
24.5100(1057,1537)

AUTHOR: Klinger, M. I.

TITLE: The theory of linear irreversible processes in a strong magnetic field

PERIODICAL: Fizika tverdogo tela, v. 3, no. 5, 1961, 1342-1353

TEXT: The object of the present work is to develop a general theory of kinetic phenomena in a strong magnetic field $H = H_z$, the phenomena being characterized by the kinetic coefficients $\sigma_{AB}(\omega)$. I. Eq.

$$\sigma_{AB}(\omega) = \int_0^{\infty} dt \exp_{\gamma \to +0}(i\omega t - \gamma t) \int_0^{\beta} d\beta' \langle B \dot{A}(t + i\beta') \rangle, \quad (1.1)$$

is written down where $\beta = 1/kT$; A, B are the operators of the corresponding electron currents (charge, energy, etc.); $A(t) = \exp(i\mathcal{H}t) A \exp(-i\mathcal{H}t)$; $\langle ... \rangle = Sp\varrho ...$; $\varrho = \exp\{\beta\Omega + \beta\mu N - \beta\mathcal{H}\}$; $\mathcal{H}$, N are the operators of the energy and particle number of the system. Instead of Eq. (1.1) a separate investiga-

Card 1/16

tion of $\sigma_{AB}^{(s)}$ and $\sigma_{AB}^{(a)}$ is preferred, where $\sigma_{AB}^{(s,a)} = 0.5(\sigma_{AB} \pm \sigma_{BA})$; (s, a = symmetric and antisymmetric part). After transformation according to Ref. (5) (R. Kubo, see below) one obtains:

$$\operatorname{Re} \sigma_{AB}^{(s)}(\omega) = (4E_\beta(\omega))^{-1} \operatorname{Re} \sum_{j=1,2} \frac{1}{2} (D_{AB}(\omega_j) + D_{BA}(\omega_j)), \quad (1.4),$$

$$\operatorname{Im} \sigma_{AB}^{(a)}(\omega) = (4E_\beta(\omega))^{-1} \operatorname{Im} \sum_{j=1,2} \frac{(-1)^j}{2} (D_{AB}(\omega)_j - D_{BA}(\omega_j)). \quad (1.5).$$

P is the sign of the principal value, furthermore

$$D_{AB}(\omega_j) = \int_{-\infty}^{\infty} \exp(i\omega_j t - \varepsilon|t|)_{\varepsilon \to +0} \operatorname{Re} \langle BA(t) \rangle; \quad E_\beta(\omega) = \frac{\omega}{2} \operatorname{cth} \frac{\beta\omega}{2}; \quad \omega_{1,2} = \pm\omega. \quad (A)$$

holds. II. To obtain $\sigma_{AB}(\omega)$ for weak scattering values of $\langle BA(t) \rangle$ and $D_{AB}(\omega_j)$ obtained in Eq. (1.5) are calculated by expansion in a power series

of λ. $\langle BA(t)\rangle$ is substituted in $D_{AB}(\omega_j)$ where $D_{AB}(\omega_j) = D_{AB}^{(o)}(\omega_j) + \lambda^2 D_{AB}^{(2)}(\omega_j)$. Substitution of $D_{AB}^{(o)}(\omega_j)$ in Eqs. (1.4), and (1.5) yields for λ^o approximately (effects independent of scattering):

$$\left.\begin{aligned} \operatorname{Re}\sigma_{AB}^{(0)(a)}(\omega) &= \pi(2E_g(\omega))^{-1}\sum_{j=1,2}\sum_{\alpha\alpha'} f_0(\alpha)(1-f_0(\alpha'))\times \\ &\times (B(\alpha\alpha'), A(\alpha'\alpha))\,\delta(\omega_j-\omega_{\alpha\alpha'}), \\ \operatorname{Im}\sigma_{AB}^{(0)(a)}(\omega) &= \pi(2E_g(\omega))^{-1}\sum_{j=1,2}(-1)^j\sum_{\alpha\alpha'} f_0(\alpha)(1-f_0(\alpha'))\times \\ &\times [B(\alpha\alpha'), A(\alpha'\alpha)]\,\delta(\omega_j-\omega_{\alpha\alpha'}), \end{aligned}\right\} \quad (2.6)$$

$$\left.\begin{aligned} \operatorname{Im}\sigma_{AB}^{(0)(s)}(\omega) &= -\omega\sum_{\alpha\alpha'} f_0(\alpha)(1-f_0(\alpha'))(E_g(\omega_{\alpha\alpha'}))^{-1}\times \\ &\times (B(\alpha\alpha'), A(\alpha'\alpha))\,P(\omega^2-\omega_{\alpha\alpha'}^2)^{-1}, \\ \operatorname{Re}\sigma_{AB}^{(0)(s)}(\omega) &= \sum_{\alpha\alpha'} f_0(\alpha)(1-f_0(\alpha'))(E_g(\omega_{\alpha\alpha'}))^{-1}\times \\ &\times [B(\alpha\alpha'), A(\alpha'\alpha)]\,P\frac{\omega_{\alpha\alpha'}}{\omega^2-\omega_{\alpha\alpha'}^2}, \end{aligned}\right\} \quad (2.7),$$

where $f_0(\alpha)$ is the equilibrium function of the electron distribution; $[B(\alpha\alpha'), A(\alpha'\alpha)] = (1/2i)(B(\alpha\alpha')A(\alpha'\alpha) - A(\alpha\alpha')B(\alpha'\alpha))$; $A(\alpha\alpha') = (\alpha|A|\alpha')$ for $\{X,Y\}$. The following results were obtained: 1) $\mathrm{Re}\,\sigma_{AB}^{(o)(s)}$ and $\mathrm{Im}\,\sigma_{AB}^{(o)(a)}$ differ from zero only at resonance frequencies $\omega_{\alpha\alpha'}$; 2) $\mathrm{Im}\,\sigma_{AB}^{(o)(s)}$ and $\mathrm{Re}\,\sigma_{AB}^{(o)(a)}$ are different from zero for all frequencies not being resonance frequencies ω_{nr}. $\mathrm{Re}\,\sigma_{xy}^{(o)(a)}$ is the Hall conductivity. $\mathrm{Re}\,\sigma_{AB}^{(s)}$ and $\mathrm{Im}\,\sigma_{AB}^{(a)}$ at $\omega = \omega_{nr}$ are calculated in λ^2 approximation (these effects depend on scattering); $\lambda^2 D_{AB}^{(2)}(\omega_j)$ is calculated. After transformation and taking into consideration the δ functions of the conservation of energy scattering contained in $D_{AB}(\omega_j)$ one obtains from Eq. (1.4):

$$\mathrm{Re}\,\sigma_{AB}^{(2,s)}(\omega_{nr}) = \pi\lambda^2 (2E_2(\omega))^{-1} \sum_{j=1,2} (e^{\beta\gamma}+1) \sum_{\substack{\alpha\alpha_1\alpha'\alpha_2 \\ \eta\eta_1}} \rho_0(\alpha\eta)(1-f_0(\alpha_1)) \times$$

$$\times\, \delta(\Omega^j_{\alpha_1\eta_1\alpha\eta})\,\mathrm{Re}\,\big((\alpha\eta_j|V|\alpha'\eta_1)(\alpha_2\eta_1|V|\alpha\eta)(\omega^j_{\alpha_2\alpha}-\omega^j_{\alpha_1\alpha_2})^{-1}\,\overline{B(\alpha'\alpha_1)A(\alpha_1\alpha_2)}^{(s,s)} - \qquad (2.8)$$

$$-\,\overline{B(\alpha'\alpha_1)A(\alpha_2\alpha)}^{(s,s)}(\alpha\eta_j|V|\alpha'\eta_1)(\alpha_1\eta_{j1}|V|\alpha_2\eta_j)(\omega^j_{\alpha_2\alpha}-\omega^j_{\alpha_1\alpha})^{-1}\big).$$

where

$$\left.\begin{array}{l}\overline{B(\alpha'\alpha_1)A(\alpha_2\alpha)}^{(s)} \equiv [B(\alpha'\alpha_1)A(\alpha_1\alpha_2)],\\ \overline{B(\alpha'\alpha_1)A(\alpha_2\alpha)}^{(a)} \equiv (-1)^j[B(\alpha'\alpha_1)A(\alpha_1\alpha_2)],\\ \Omega^j_{\alpha_1\alpha_2;\alpha\alpha'} \equiv \omega^j_{\alpha\alpha'} + \varepsilon_{\alpha_2} - \varepsilon_{\alpha_1};\ \omega^j_{\alpha\alpha'} \equiv \omega_{\alpha\alpha'} + \omega_j,\end{array}\right\} \quad (2.9);\ \varrho_0(\alpha\eta)$$

is the equilibrium function of the distribution in the nonperturbed system. $\sigma_{AB}(\omega)$ in strong magnetic field can be calculated from Eqs. (2.6), (2.7), and (2.8). III. Kinetic phenomena in strong magnetic field in the gas free electrons. 1) For free electrons with effective mass m, $\alpha = (n,k) = \bar{n}$, $k = k_y$, $n = 0$, one has

$$|\alpha\rangle = \exp(iyk_y + izk_z)\,\Phi_n(x - x_\alpha),\quad x_\alpha = -k_y(m\omega_0)^{-1}, \qquad (B)$$

where $\Phi_n(x)$ is the state vector of the unidimensional Landau oscillator (L. D. Landau, 1930). First the λ^0 effects are investigated. For the electric conductivity (with arbitrary degeneracy of the electrons) the following Eqs. are written:

23102

The theory of linear ... S/181/61/003/C05/C07/042
B101/B214

$$\left.\begin{aligned} \mathrm{Re}\,\sigma_{xx}^{(o)} &= (e^2N/m)(\pi/2)\delta(\omega - \omega_o); \\ \mathrm{Im}\,\sigma_{xy}^{(o)(a)} &= -(e^2N/m)(\pi/2)\delta(\omega - \omega_o) \end{aligned}\right\} \qquad (3.1).$$

For $\omega = \omega_{nr} \neq \omega_o$ $\mathrm{Im}\,\sigma_{xx}^{(o)} = (e^2N/m)\left[\omega/(\omega^2 - \omega_o^2)\right]$; $\mathrm{Re}\,\sigma_{xy}^{(o)} = (e^2N/m)\omega_o/(\omega^2 - \omega_o^2)$; $\sigma_{xy}^{(o)}(\omega = 0) = (eN/H)c$ (3.2). N = concentration of the electrons. For the antisymmetric Peltier coefficients the following is written down: $\Pi_{xy}^{(o)(a)}(\omega = 0) = (eN/m\omega_o)\left[kT/2 + \omega_o \mathrm{cth}(\beta\omega_o/2)\right]$ (3.3). 2) λ^2 effects are obtained from Eq. (2.9) after transformation: a) For the electric conductivity

$$\mathrm{Re}\,\sigma_{xx}(\omega_{nr}) = \sigma'_{xx}(\omega) + \sigma''_{xx}(\omega), \qquad (3.5),$$

$$\sigma'_{xx}(\omega) = \frac{\pi\lambda^2 e^2\omega_0^4}{2E_\beta(\omega)(\omega_0^2 - \omega^2)^2} \sum_{\substack{\alpha\eta \\ \alpha_1\eta_1}} \sum_{j=1,2} \rho_0(\alpha\eta)\,\delta(\Omega^j_{\alpha_1\eta_1\alpha\eta})\,|\langle\alpha_1\eta_1|V|\alpha\eta\rangle|^2 \times$$

$$\times (1 - f_0(\alpha_1))(x_\alpha - x_{\alpha_1})^2, \qquad (3.6),$$

Card 6/16

The theory of linear ... S/181/61/003/005/007/042
B101/B214

$$\sigma^{e}_{xx} = \frac{\pi\lambda^2 e^2 \omega_{\omega_0}}{8mE_g(\omega)(\omega_0^2-\omega^2)^2} \sum_{j=1,2} \sum_{\substack{a\eta \\ a_1\eta_1}} \rho_0(a\eta)\,\delta(\Omega^{e}_{a_1\eta_1 a\eta})\,(1-f_0(a_1)) \times$$
$$\times \left\{ \frac{\omega}{\omega_0^2} \left| \left(a_1\eta_1 \left| \frac{\partial V}{\partial x} \right| a\eta\right)\right|^2 (e^{\beta\omega_j}+1) + 4(-1)^j (e^{\beta\omega_j}-1)\,\omega_0 \,\mathrm{Re} \times \right.$$
$$\left. \times \left[(a\eta|(x-x_a)V|a_1\eta_1) \left(a_1\eta_1 \left| \frac{-\partial V}{\partial x} \right| a\eta\right) \right] \right\}. \qquad (3.7).$$

b) For the thermomagnetic coefficients:

$$\varkappa_{xx} = \sigma^{(0)}_{x_0 x_0}(\omega = 0)$$
$$\Pi_{xx} = \pi\lambda^2\beta e \sum_{a_1\eta\eta_1} \rho_0(a\eta)\,\delta(\Omega_{a_1\eta_1 a\eta})\,|(a_1\eta_1|V|a\eta)|^2 (x_a - x_{a_1})^2 \frac{1}{2}(\varepsilon_a + \varepsilon_{a_1})\,(1-f_0(a_1)), \qquad (3.8),$$
$$\varkappa_{xx} = \varkappa^{0}_{xx} + \varkappa'_{xx} + \varkappa''_{xx},$$

Card 7/16

23102

S/181/61/003/005/007/042
B101/B214

$$\varkappa^{0}_{xx}=\pi\lambda^{2}\beta\sum_{\alpha_1\eta_1}\rho_0(\alpha\eta)\,\delta(\Omega_{\alpha_1\eta_1\alpha\eta})\Big\{|(\alpha_1\eta_1|V|\alpha\eta)|^{2}(x_\alpha-x_{\alpha_1})^{2}\varepsilon_\alpha\varepsilon_{\alpha_1}+$$

$$+\varepsilon_{\alpha_1}\frac{2m\omega}{q_0^{2}}(x_{\alpha_1}-x_\alpha)\,\mathrm{Re}\,(\alpha_1\eta_1|V|\alpha\eta)\Big(\alpha\eta\Big|V\frac{\partial}{\partial x}\Big|\alpha_1\eta_1\Big)\Big\}(1-f_0(\alpha_1)),$$

$$\varkappa'_{xx}=\frac{\pi\lambda^{2}\beta\omega^{2}}{2q_0^{4}}\sum\rho_0(\alpha\eta)\,\delta(\Omega_{\alpha_1\eta_1\alpha\eta})\Big\{2\Big|\Big(\alpha_1\eta_1\Big|V\frac{\partial}{\partial x}\Big|\alpha\eta\Big)\Big|^{2}+ \qquad (3.9).$$

$$+\mathrm{Re}\Big(\alpha_1\eta_1\Big|\frac{\partial V}{\partial x}\Big|\alpha\eta\Big)\Big(\alpha\eta\Big|V\frac{\partial}{\partial x}\Big|\alpha_1\eta_1\Big)\Big\}(1-f_0(\alpha_1)),$$

$$\varkappa''_{xx}=\pi\lambda^{2}\beta\sum\rho_0(\alpha\eta)\,\delta(\Omega_{\alpha_1\eta_1\alpha\eta})(\varepsilon_\alpha-\varepsilon_{\alpha_1})\times$$

$$\times\Big\{\varepsilon_\alpha|(\alpha_1\eta_1|xV|\alpha\eta)|^{2}+\frac{2m\omega}{q_0^{2}}\mathrm{Re}\,(\alpha_1\eta_1|xV|\alpha\eta)\Big(\alpha\eta\Big|V\frac{\partial}{\partial x}\Big|\alpha_1\eta_1\Big)\Big\}(1-f_0(\alpha_1)).$$

Hence it follows that 1) $\varkappa^{0}_{xx}$ is determined by the contribution of the migration of the oscillation centers; 2) $\varkappa'_{xx}$ and $\varkappa''_{xx}$ contain moreover a contribution also of the relative motion of the oscillators. The Eqs. (3.5)-(3.9) are used for scattering at phonons where $\lambda V = \sum_{\vec q} C_{\vec q}\exp(i\vec q\vec x)(b_{\vec q} - b^{+}_{-\vec q})$. $C_{\vec q}$ are the interaction coefficients; and $b_{\vec q}$ and $b^{+}_{\vec q}$ are the operators of the

quantized phonon field. The following is written down for nondegenerate electron gas:

$$\mathrm{Re}\,\sigma_{xx} = \frac{\text{[illegible]}}{4mE_g(\omega)(\omega_0^2-\omega^2)^2}\sum_{j=1,2}\sum_{q_xq_y;\,q_z>0}|C_q|^2\left(\mathrm{sh}\frac{\beta\omega_q}{2}\,\mathrm{sh}\frac{\beta\omega_q'}{2}\right)^{-1}\times$$
$$\times\,\zeta\left[\left(\omega_0^2+\frac{\omega^2}{2}\right)\mathrm{ch}\frac{\beta\omega}{2}+4\omega\omega_0\,\mathrm{sh}\frac{\beta\omega}{2}\frac{\partial}{\partial\omega}\right]\Phi_j(\zeta,q), \qquad (3.10).$$

$$\Pi_{xx} = (\pi\lambda^2\beta e/2)\sum_{q_xq_y;\,q_z>0}\left[|C_q|^2/\mathrm{sh}^2(\beta\omega_q/2)\right](\zeta/q_0^2)\,\bar{r}^{(1)};$$

$$\zeta = q_\perp^2\,q_0^{-2};\quad q_\perp^2 = q_x^2+q_y^2;\quad \omega_q^{\pm} = \omega_q \pm \omega_j;$$

In this, account has been taken of the fact that $f_0(\alpha)(1-f_0(\alpha_1))\left[N_q\delta(\Omega_-)+(1+N_q)\delta(\Omega_+)\right] \longrightarrow 2(f_0(\alpha_1)-f_0(\alpha))N_q(1+N_q)\delta(\Omega_+)$; $\Omega_\pm = \varepsilon_{\alpha 1}' - \varepsilon_\alpha \pm \omega_q$. Further the following Eq. is obtained:

Card 9/16

The theory of linear ... S/181/61/003/005/007/042
B101/B214

$$x_{\alpha\alpha} = \frac{\pi i e^2}{2} \sum \frac{|C_q|^2}{\mathrm{sh}^2\left(\frac{\beta\omega_q}{2}\right)} \left\{ \frac{\zeta}{q_0^2} \left[\Psi^{(2)} + \frac{\omega_0^2 - \omega_1^2}{2} \frac{1}{2} \Phi(q) \right] + \right.$$

$$+ \left[2\omega_0^2 \left(2 \frac{\partial^2}{\partial q_y \partial q_y'} + \frac{q_z}{q_0^2} \mathrm{Im} \frac{\partial}{\partial q_y} \right) + \right.$$

$$\left. \left. + 2\omega_0 \left(\omega_0 \frac{\partial^2}{\partial q_x \partial q_x'} - 2\omega_0 \mathrm{Im} \frac{\partial^2}{\partial q_y \partial q_x'} \right) \right] S(q, q')|_{q=q'} \right\} . \quad (3.11).$$

In Eqs. (3.10) and (3.11) the following notations are introduced:

$$\left. \begin{array}{l} S_j(q, q') = \sum\limits_{\alpha_1} \delta(\Omega_+)(f_0(\varepsilon_1) - f_0(\varepsilon)) L_{\alpha\alpha'}(q) L^*_{\alpha\alpha'}(q'), \\ \Psi^{(r)}(q) = \sum \delta(\Omega_+)(f_0(\varepsilon_1) - f_0(\varepsilon)) \left(\frac{\varepsilon_\alpha + \varepsilon_{\alpha_1}}{2} \right)^r |L_{\alpha\alpha_1}(\zeta)|^2, \; r = 1, 2, \end{array} \right\} \quad (3.12),$$

$$\left. \begin{array}{l} S(q, q') \equiv S_j(q, q')|_{\omega=0}; \quad \Phi_j(q) \equiv S_j(q, q')|_{q'=q}, \\ \Phi(q) = S(q, q')|_{q=q'}; \; q, q' \equiv (q_x, q_y), (q_x', q_y'), \\ |L_{\alpha\alpha_1}(\zeta)|^2 = \left| \int\limits_{-\infty}^{\infty} \Phi_\alpha(x - x_\alpha) e^{i\zeta x} \Phi_{\alpha_1}(x - x_{\alpha_1}) dx \right|^2 . \end{array} \right| \quad (3.13).$$

Card 10/16

With the help of the derivative function for Hermite polynomials the series in Eq. (3.12) are summed for electron quantum numbers and the following is obtained:

$$\begin{aligned}
\operatorname{Re}\sigma_{zz} &= \frac{n\lambda^2 e^2 \omega_0^2 e^{\beta\mu}}{2E_g(\omega)(\omega_0^2-\omega^2)^2} \sum_j \sum_{n(\omega)>0} \frac{|C_q|^2\zeta}{\operatorname{sh}\frac{\beta\omega_q}{2}\, q_z} \times \\
&\times Z_0\left[\left(\omega_0^2+\frac{\omega^2}{2}\right)\operatorname{ch}\frac{\beta\omega}{2} + 4\omega\omega_0\operatorname{sh}\frac{\beta\omega}{2}\left(\frac{\partial}{\partial\zeta}\right)_j\right]\Lambda_j^{(\varphi)}, \\
\Pi_{zz} &= n\lambda^2\beta e^{\beta\mu} e \sum_{n(\omega)>0} \frac{|C_q|^2\zeta}{\operatorname{sh}\frac{\beta\omega_q}{2}\, q_z} \frac{\partial}{\partial\beta}\left(Z_0\Lambda_0^{(\varphi)}\right), \\
\varkappa_{zz} &= n\lambda^2\beta e^{\beta\mu} \sum_{n(\omega)>0} \frac{|C_q|}{\operatorname{sh}\frac{\beta\omega_q}{2}\, q_z} \left\{\sum_{l=0,1,2} D_l Z_0 \Lambda_0^{(l)} + \frac{\partial^2}{\partial\beta^2}\left(Z_0\Lambda_0^{(\varphi)}\right)\right\},
\end{aligned} \qquad (3.14)$$

where

$$Z_0 = \left(\sqrt{\pi\beta}\,\operatorname{sh}\frac{\beta\omega_0}{2}\right)^{-1} \exp\left[-\frac{\beta\omega_0^2}{8m} - \frac{\zeta}{2}\operatorname{cth}\frac{\beta\omega_0}{2}\right], \qquad (C);$$

$$\Lambda_j^{(1)} = \int_{-\infty}^{\infty} (dz/2\pi)\exp\left[-z^2/\beta + \varphi\cos(\sqrt{2m}\,\omega_o z/q_z)\right]\cos(\sqrt{2m}\,\omega_q^1 z/q_z)\cos^1(\sqrt{2m}\,\omega_o z/q_z);$$

$$\varphi = \zeta/2\mathrm{sh}(\beta\omega_o/2);\ \Lambda_o^{(1)} = \Lambda_j^{(1)}\omega_j = 0;\ D_o = (\zeta/4)\left[\omega_o^2 + \omega_q^2(\mathrm{cth}^2(\beta\omega_o/2) - 2\bar{n}^2)\right];$$

$$D_1 = 2(1 + \bar{n})/\mathrm{sh}(\beta\omega_o/2)\left[(\omega_o^2 + \omega_q^2)(1 + (\zeta/4)\mathrm{cth}(\beta\omega_o/2)\right];$$

$$D_2 = -\left[(1 + \bar{n})/\mathrm{sh}(\beta\omega_o/2)\right]\varphi(\omega_o^2 + \omega_q^2);\ \bar{n} = \left[\exp(\beta\omega_o^1) - 1\right]^{-1} \quad (3.14).$$

The results of calculation for different scatterings in the quantum limit $\beta\omega_o \gg 1$ are given in the table. A. I. Ansel'm, A. Askarov, V. L. Gurevich, Yu. A. Firsov are mentioned. A. G. Samoylovich is thanked for discussions. There are 12 references: 6 Soviet-bloc and 6 non-Soviet-bloc. The reference to English-language publication reads as follows: R. Kubo, et al. J. Phys. Soc. Jap., 12, 570, 1957.

ASSOCIATION: Institut poluprovodnikov AN SSSR Leningrad (Institute of Semiconductors, AS USSR, Leningrad)

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AUTHOR: Klinger, M. I.

TITLE: Derivation of a kinetic quantum equation for a strong magnetic field

PERIODICAL: Fizika tverdogo tela, v. 3, no. 5, 1961, 1354-1365

TEXT: In the preceding paper (Ref. 1: FTT, v. 3, no. 5, 1961, 1342-1353) a theory of the kinetic coefficients $\sigma_{AB}(\omega)$ in strong magnetic field was developed. The same notations are used in the present paper and a quantum mechanical analysis of the kinetic equation is given. 1) The following is written down for deriving the fundamental equation of transfer in a strong magnetic field:

$$\left.\begin{array}{l}\sigma_{AB}(\omega)=\int\limits_0^\infty dt e^{iEt}\int\limits_0^\beta d\beta' \langle BA(t+i\beta')\rangle,\\ E=\omega+i\varepsilon,\ \varepsilon\to+0.\end{array}\right| \qquad (2.1).$$

Card 1/13

23103